APPENDIX 1

Terrestrial Habitat Evaluation Procedures

Terrestrial Habitat Evaluation Procedures

Introduction

The U.S. Army Corps of Engineers (USACE), Little Rock and Tulsa Districts, in association with the preparation of an Environmental Impact Statement (EIS) to evaluate the environmental impacts of the proposed dredging and flow changes on the McClellan-Kerr Arkansas River Navigation System (MKARNS), have completed Habitat Evaluation Procedures (HEP) to determine impacts resulting from dredge disposal on terrestrial habitat along the MKARNS and ecological benefits resulting from the proposed mitigation. The use of a community habitat assessment approach for a HEP application in a navigation study demonstrates the effectiveness of these models in the evaluation of potential impacts and mitigation success.

The HEP methodology is an environmental accounting process developed to appraise habitat suitability for fish and wildlife species in the face of potential change (USFWS, 1980a-c). Designed to predict the response of habitat parameters in a quantifiable fashion, HEP is an objective, reliable, and well-documented process used nationwide to generate environmental outputs for all levels of proposed projects and monitoring operations in the natural resources arena. When applied correctly, HEP provides an impartial look at environmental effects, and delivers measurable products to the user for comparative analysis.

In HEP, a Suitability Index, or SI is a mathematical relationship that reflects a species' or community's sensitivity to a change in a limiting factor (i.e., variable) within the habitat type. These suitability relationships are depicted using scatter plots and bar charts (i.e., suitability curves). The SI value ranges from 0.0 to 1.0, where an SI = 0.0 represents a variable that is extremely limiting, and an SI = 1.0 represents a variable in abundance (not limiting) for the species or community. In HEP, a Habitat Suitability Index (HSI) model is a quantitative estimate of habitat conditions for an evaluation species or community. HSI models combine the SIs of measurable variables into a formula depicting the limiting characteristics of the site for the species/community on a scale of 0.0 (unsuitable) to 1.0 (optimal).

The HEP was designed to evaluate the future changes in quantity (acres) and quality (habitat suitability and functional capacity) of terrestrial ecosystems. Outputs were calculated in terms of annualized changes anticipated over the life of the project [i.e., Average Annual Habitat Units (AAHUs)] in the HEP analyses.

Building a Multidisciplinary Evaluation Team

Early in the evaluation process, a Multiagency Ecosystem Evaluation Team (MEET) was convened. This was a multidisciplinary team that included various interests and technical expertise. To date, the following team members have contributed to the effort:

- Mr. Johnny McLean, USACE Little Rock District
- Mr. Tony Hill, USACE Little Rock
- Ms. Sandra Stiles, USACE Tulsa District
- Mr. Wesley Fowler, USACE Tulsa District

- Mr. Charles Schrodt, USACE Tulsa District
- Mr. Richard Stark, U.S. Fish and Wildlife Service (USFWS), Oklahoma
- Mr. Kevin Stubbs, USFWS, Oklahoma
- Mr. Lindsey Lewis, USFWS, Arkansas
- Ms. Marge Harney, USFWS
- Mr. Craig Uyeda, Arkansas Game & Fish Commission (AGFC)
- Mr. Jeff Quinn, AGFC
- Mr. J.D. Ridge, Oklahoma Department of Wildlife Conservation (ODWC)
- Mr. Gary Peterson, ODWC
- Mr. Mike Plunkett, ODWC
- Mr. Randy Hyler, ODWC
- Mr. Stephen Weber, Oklahoma Department of Environmental Quality
- Ms. Antisa Webb, U.S. Army Engineer Research and Development Center Environmental Laboratory (ERDC-EL)
- Ms. Kelly Burks-Copes, ERDC-EL
- Mr. Richard Hall, Contractor, Parsons Corp.
- Mr. Randy Norris, Contractor, Parsons Corp.
- Ms. Virginia Flynn, Contractor, Parsons Corp.
- Ms. Enid McNutt, Contractor, Parsons Corp.
- Mr. Luke Eggering, Contractor, Parsons Corp.

Defining the Project

Geographic Location, Watersheds, and Primary Water Resources

The affected environment includes the MKARNS from the Port of Catoosa near Tulsa, Oklahoma downstream to the confluence of the Mississippi River in southeastern Arkansas as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS.

The MKARNS is approximately 445 miles in length and consists of a series of 18 locks and dams (17 existing and 1 currently under construction). The principal components of the MKARNS waterways include:

- A 50 mile portion of the Verdigris River (navigation miles 445-394);
- Lower Arkansas River, which comprises 375 miles of the MKARNS (navigation miles 394 to 19);
- The Arkansas Post Canal, a nine mile canal connecting the Arkansas River to the lower

portion of the White River (navigation miles 19 to 10); and

- The lower 10 miles of the White River (navigation miles 10 to 0);
- The Lower Arkansas River downstream of Dam 2 (not formally part of the MKARNS). This portion of the Arkansas River is included in the Arkansas River Navigation Study project area because MKARNS river flows may also influence this segment of the river.

River flows on the MKARNS are primarily influenced by flows on the upper Arkansas River upstream of the confluence with the Verdigris River (river mile 394); as well as water storage and release from 11 reservoirs in Oklahoma. These reservoirs provide flood control, water supply, hydroelectric power, fish & wildlife, recreation, and other benefits.

More detailed information on the MKARNS environment is available in Section 4 of the EIS.

Lead District

The MKARNS falls under the purview of the USACE, Little Rock District, Arkansas. The effort is being carried out in conjunction with the USACE, Tulsa District, Oklahoma. These Districts are two of four districts that make up the USACE Southwestern Division. The planning lead for the Navigation Study is Mr. Ron Carman (Little Rock District), and the environmental leads for the study are Mr. Johnny McLean (Little Rock District) and Ms. Sandra Stiles (Tulsa District).

Project Purpose

Site-specific HEPs were conducted to evaluate potential impacts of the construction and use of proposed dredge disposal areas. The primary purpose was to assist the study team in formulating a recommended plan by providing a quantitative measure or qualitative evaluation of environmental impacts and estimated habitat replacement costs. Detailed analysis of site-specific impacts, based on any recommended/authorized measures, will not be possible until detailed design information for those measures is available. Should future construction activities be recommended, detailed site-specific evaluations would be completed for each incremental step towards completion of the action. Site surveys would be conducted to determine the potential for environmental impacts.

Determining Goals and Objectives, Project Life, and Target Years.

A meeting was convened early in March of 2004 to conduct the HEP for the MKARNS EIS. The MEET was asked to outline the primary systems or communities within the project area in order to gauge the impacts of the proposed alternatives. Specifically, these impact parameters focused on the existing habitat quantity and quality. First, the MEET developed a list of existing cover types in the region. These are shown in Table 1.

Table 1. Cover Types Within the ARNS Region.

Code	Description
AGCROP	Farms and Croplands
BLHFOREST	Bottomland Hardwood Forest (BLH)

Table 1. Cover Types Within the ARNS Region.	
OLDFIELD	Old Fields Dominated by Grasses with > 25% Woody Cover (OLF)
OPENFIELD	Open Fields Dominated by Grasses with < 25% Woody Cover (OF)
OPENWATER	Open Bodies of Water Deeper than 1-3m
PARKS	Parks and Recreation Areas
PASTURES	Haylands and Pastures
UPFOREST	Upland Forest (UPL)
URBAN	Existing Residential, Industrial and Transportation Avenues
DISPOSAL	Disposal Pit Footprint
Source: ERDC-EL, 2004	

The MEET then outlined the potential project alternatives and mitigation activities, and created a list of proposed changes to the cover types over time resulting from natural succession or mitigation activities. These changes resulted in "newly developed" cover types including those listed in Table 2. The MEET chose two alternatives for the study to intensively evaluate with HEP:

- Dredge disposal from deepening, and/or continued operation and maintenance of the ARNS; and
- No action alternative.

Table 2. Potential Newly Created Cover Types Within the ARNS.

Code	Description
NEWBLHFOR	Newly Developed Bottomland Hardwood Forest
NEWOLD	Newly Developed Old Field (> 25% Woody Cover)
NEWOPEN	Newly Developed Open Fields (< 25% Woody Cover)
NEWUPFOR	Newly Developed Upland Forest
NEWMARSH	Newly Developed Emergent Marsh
Source: ERDC-EL, 2004	

Cover Type Mapping the Sites

To evaluate the habitat conditions for a species or community using HEP, the study area was divided into manageable sections and quantified in terms of acres. This process is known as cover typing. A cover type in HEP is a parcel of land (or water) that has similar physical, chemical, and biological characteristics contained within its borders. Cover typing includes defining the differences between vegetative covers (e.g., tall grass prairie, forested wetlands, shrub lands, lakes, and streams, etc.), and clearly delineating these distinctions on a map. The quality of each cover type for the selected species or community is determined by measuring individual variables within the site. Some examples of HEP variables used in this study included the amount of herbaceous cover, the amount of woody cover, the distance to water, the number of pools, number of species, and adjacent land use for a given cover type. In most instances, these variables are measured using aerial photographs, maps and/or onsite sampling activities.

Cover type for each site evaluated was mapped using existing aerial photography and information from transects in the field. All areas adjacent to and within the proposed site were mapped.

Capturing Changes Over Time in HEP Applications

In studies spanning several years, Target Years (TYs) must be identified early in the process. Target Years are units of time measurement used in HEP that allow users to anticipate and identify significant changes (in area or quality) within the project (or site). As a rule, the baseline TY is always TY = 0, where the baseline year is defined as a point in time before proposed changes would be implemented. As a second rule, there must always be a TY = 1 and a TY = X_2. TY1 is the first year land- and water-use conditions are expected to deviate from baseline conditions. TYX_2 designates the ending target year or the span of the project's life. A new target year must be assigned for each year the user intends to develop or evaluate change within the site or project. The habitat conditions (quality and quantity) described for each TY are the expected conditions at the end of that year. It is important to maintain the same target years in both the environmental and economic analyses, and between the baseline and future analyses. In studies focused on long-term effects, Habitat Units (HUs) generated for indicator species/communities are estimated for several TYs to reflect the life of the project. In such analyses, future habitat conditions are estimated for both the without-project (e.g., No Action Alternative) and with-project conditions. Projected long-term effects of the project are reported in terms of AAHUs. Based on the AAHU outcomes, alternative designs can be formulated and trade-off analyses can be conducted to promote environmental optimization (ERDC-EL, 2004a).

The USACE designated a "Project Life" of 50 years for the ARNS, and asked the MEET to develop a series of Target Years within this 50-year setting to generate projections of both Without Project and With Project activities. Target years for the ARNS therefore included TY0 (Baseline Conditions), TY1 (Year of Construction), TY11 (Early in Project), T31 (Middle of Project) and TY51 (End of Project) to capture this 50-year span. The TY11 and TY31 were added to capture important anticipated changes in vegetative cover and structure in the study area.

Selecting, Modifying, and/or Creating Models

With the cover types identified, and their distributions and quantities revealed, the MEET attempted to set quantifiable impact measures and mitigation performance measures for the proposed actions. The impact measures focused on the quantity (measured in acres) and quality (measured in terms of Habitat Suitability Indices or HSIs) of habitat lost or created throughout the life of the project. The mitigation criteria focused on the recovery of a specific habitats, defined on the basis of quantity recovered, and obtainable habitat quality.

HSI models can be tailored to a particular situation or application and adapted to meet the level of effort desired by the user. Thus, a single model (or a series of inter-related models) can be adapted to reflect a site's response to a particular design at any scale (e.g., species, community, ecosystem, regional, or global dimensions). HEP combines both the habitat quality (HSI) and quantity of a site (measured in acres) to generate habitat units (HUs). Once the HSI and habitat quantities have been determined, the HU values can be mathematically derived with the following equation: HU = HSI x Area (acres). Under the HEP methodology, one HU is equivalent to one acre of optimal habitat for a given species or community (ERDC-EL, 2004a).

Three HSI models, each with three sub-models, were deployed in the HEP assessments. The forest and grassland models applied to the impact sites, while the marsh model applied to the mitigation sites. The HSI models were developed and modified by the MEET, and used to evaluate the relationships within terrestrial and marsh communities in the Arkansas River ecosystem setting.

Table 3. HSI Model List for ARNS EIS.

Model	Model Codes	Description
FORESTS	FBIOTA	Biota of the Forest Community
	FWATER	Water Component of the Forest Community
	FLANDSCAPE	Landscape Component of the Forest Community
GRASSLANDS	GBIOTA	Biota of the Grassland Community
	GLANDSCAPE	Landscape Component of the Grassland Community
MARSH	MBIOTA	Habitat (Biota) Component for Marsh Community
	MLANDSCAPE	Landscape Component for Marsh Community

Source: ERDC-EL, 2004b

Site Data Collection

In the spring of 2004, members of the MEET completed intensive baseline habitat sampling at 22 sites across the Arkansas River ecosystem. These sites were considered upland/terrestrial sites. Of the 22 HEP sites, 6 sites served as reference standard sites (RSS) for the calibration of the HEP models. These sites were not potential dredge disposal sites, but examples of typical forest and grassland habitat within the study area. Twelve of the HEP sites were targeted as potential dredge disposal locations above the floodplain. These sites were used as reference impact sites (RIS) to develop baseline conditions in the HEP analysis and used to extrapolate impacts to sites not surveyed. A total of 13 HSI variables were measured during the field sampling effort in an attempt to develop a description of the baseline (Spring 2004) conditions at these sites. Variables ranged from measurements of vegetative cover to the counting of the number of species. These variables are described in detail in Table C-4 below. The sampling effort could be completed efficiently on 100-meter (m) transects.

Some variables could be obtained through various historical records, aerial photos or mathematical calculations rather than through active field sampling. Six HSI variables were obtained from Geographic Information System (GIS) resources and spreadsheet calculations. These variables are described in detail in Table 5.

The following methods were used to obtain some of those variables:

- Landcover types were mapped using aerial photography and information from transects in the field. Mapped areas were immediately adjacent to proposed sites.
- Acreage for PATCH variable was calculated within the GIS software.
- A 100m buffer was applied inside patch and acreage of buffer calculated using GIS software. Buffer acreage was divided by the PATCH variable to obtain an edge variable.
- Buffer acreage was subtracted from total PATCH variable acreage to obtain core acreage. The difference in PATCH acreage and buffer acreage was divided by PATCH acreage to obtain the CORE variable.
- An automated routine within the GIS software was used to determine a centerpoint for each patch. Using the centerpoint, the DISTOPW (distance to open water) variable was measured using the measure tool in ArcGIS. The NEIGHBOR (nearest neighbor) variable was determined the same way.
- The ADLAND variable was obtained by generating 30 random points within the patch and visually determining the adjacent land use.

Table 4. Variables Measured in the Field.					
VAR Code	**Variable Description**	**Methodology, Techniques and Assumptions**	**Model Applicability**	**Cover Type Cross-Reference**	**Equipment List**
CANEMERG	Emergent Herbaceous Vegetation Canopy Cover (%)	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the percent of the water surface shaded by a vertical projection of the canopies of emergent herbaceous vegetation, both persistent and nonpersistent.	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and 1-m2 Quadrat
CANFORB	Proportion of the Herbaceous Canopy Cover Comprised of Forbs (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the proportion of the herbaceous canopy cover within the quadrat that is comprised of forbs. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANHERB	Herbaceous Canopy Cover (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the herbaceous canopy cover within the quadrat. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANHMAST	Proportion of the Tree Canopy Comprised of Hard Mast Species (%)	Starting at a random location within each forest-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground. Stand in the center of this quadrat and use an optic tube to determine the percent of the tree canopy within the viewer that is comprised of hard mast species. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the process two more times (total number of data points = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape, 1-m2 Quadrat and Optic Tube

Table 4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
CANNATIVE	Proportion of the Herbaceous Canopy Cover Comprised of Native Species (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the proportion of the herbaceous canopy cover within the quadrat that is comprised of native species. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANSHRUB	Shrub Canopy Cover (%)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the shrub canopy cover within the quadrat. By definition, shrubs are defined as woody vegetation less than 20 feet tall (dbh < 6 inches). Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
CANSMAST	Proportion of the Tree Canopy Comprised of Soft Mast Species (%)	Starting at a random location within each forest-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground. Stand in the center of this quadrat and use an optic tube to determine the percent of the tree canopy within the viewer that is comprised of soft mast species. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the process two more times (total number of data points = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape, 1-m2 Quadrat and Optic Tube
CANTREE	Percent Tree Canopy Cover (%)	Starting at a random location within each forest-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground. Stand in the center of this quadrat and use an optic tube to determine the percent tree canopy within the viewer. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the process two more times (total number of data points = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape, 1-m2 Quadrat and Optic Tube

Table 4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
CANWOOD6	Percent Canopy Cover of Woody Vegetation < 6m Tall (%)	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and estimate the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation.	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and 1-m2 Quadrat
DBHTREE	Average Tree Diameter (dbh) (cm)	Starting at a random location within each forest-based cover type, lay out a 100-m transect tape. Establish a 10-m wide belt transect parallel to the 100-m transect tape (5-m on each side of the tape). Walk along this belt for 10-m, and measure the diameter at breast height of all trees >10 dbh or taller than 20 feet within the belt. Repeat the 10x10 belt approach for the length of the 100-m transect tape (10 sets of data points are collected per 100-m transect). Repeat the process two more times (total number of data point sets = 30 per cover type).	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape and DBH Tape
DEPTHWATER	Average Water Depth in centimeters (cm)	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a graduated rod or meter stick perpendicular to the ground and measure the water depth (cm).	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and Graduated Rod or Meter Stick
DIVERSVEG	Diversity of Indicator Species	Starting at a random location within each marsh-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, walk out 5m in all 4 directions of the tape and record the category of indicator species that best represents the 10-m square section along the belt.Class Data:0 = No Data Collected1 = Cattails, Cordgrasses, Bulrushes2 = Bluejoint Reedgrass, Reed Canary-Grass, Sedges3 = Buttonbush, Mangrove4 = Other Growth Forms not listed.	MARSH MBIOTA	NEWMARSH	100-m Transect Tape and 10-m2 belt section

Table 4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
NUMSPP	Number of Species Present (Count)	Starting at a random location within each grassland-based cover type, lay out a 100-m transect. At every 10-m interval along the transect, place a 1-m2 quadrat on the ground and record then total number of species present within the quadrat. Repeat the process two more times (total number of data points = 30 per cover type).	GRASSLANDS GBIOTA	OLDFIELD NEWOLD OPENFIELD NEWOPEN	100-m Transect Tape and 1-m2 Quadrat
NUMTREESP	Number of Tree Species Present (Count)	Starting at a random location within each forest-based cover type, lay out a 100-m transect tape. Establish a 10-m wide belt transect parallel to the 100-m transect tape (5-m on each side of the tape). Walk along this belt for 10-m, and identify (to species) trees within the belt. By definition, trees must be at least 20 feet tall and/or have a dbh of 6 inches to be included in this measurement. Repeat the 10x10 belt approach for the length of the 100-m transect tape (10 sets of data points are collected per 100-m transect). Repeat the process two more times (total number of data point sets = 30 per cover type). Sum the number of species found per transect.	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape and DBH Tape
VEGSTRATA	Number of Vegetation Strata Present (Count)	Starting at a random location within each forest-based cover type, lay out a 100-m transect tape. Establish a 10-m wide belt transect parallel to the 100-m transect tape (5-m on each side of the tape). Walk along this belt for 10-m, and identify all vegetative layers present (see list below). Repeat the 10x10 belt approach for the length of the 100-m transect tape (10 sets of data points are collected per 100-m transect). Repeat the process two more times (total number of data point sets = 30 per cover type). Vegetative Layers to Record Include: Herbaceous - herbaceous vegetation layer less than 1m (39 inches) in height. Shrubs - woody vegetation layer less than 3m (~10ft) in height. Midstory Tree Canopy - woody vegetation layer 3-6m (~10-20 ft) in height.	FORESTS FBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	100-m Transect Tape

Table 4. Variables Measured in the Field.

VAR Code	Variable Description	Methodology, Techniques and Assumptions	Model Applicability	Cover Type Cross-Reference	Equipment List
		Overstory Tree Canopy - woody vegetation layer greater than 6m (~20 ft) in height. Vines - woody vines allowing for travel lanes Duff, Twigs, Leaf Litter - down or dead wood or herbaceous litter Coarse Woody Debris - down or dead wood debris greater than or equal to 10 cm (2.5 inches) diameter. Snags - dead but standing trees. Micro Relief - small pockets or mounds that may allow for cover or ponding water.			

Source: ERDC-EL, 2004b

Table 5. Variables Gathered via GIS & Historical Records.					
VAR Code	**Variable Description**	**Methodology, Techniques and Assumptions**	**Model Applicability**	**Cover Type Cross-Reference**	**Equipment List**
ADJLANDUSE	Identification of Adjacent Lands Use (Class Data)	Using GIS, select 30 random points within each cover type and identify the predominant adjacent landuse type based on the following categories. Class data: NEED Better definitions 1 = Pristine, Uninhabited Areas 2 = Parks 3 = Pasturelands 4 = Utility Rights-of-way and Rail Roads 5 = Dirt and Gravel roads, Oil and Gas Fields 6 = Agricultural Croplands 7 = Residential and Golf Courses 8 = Paved Roads, Highways 9 = Commercial/Industrial	FORESTS FLANDSCAPE GRASSLANDS GLANDSCAPE MARSH MLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR OLDFIELD NEWOLD OPENFIELD NEWOPEN NEWMARSH	GIS & Calculations
CORE	Proportion of Total Area that is Core (%)	Using GIS, determine the proportion (%) of the total area of the cover type polygon that is core area.	FORESTS FLANDSCAPE GRASSLANDS GLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR OLDFIELD NEWOLD OPENFIELD NEWOPEN	GIS & Calculations
DISTOPW	Average Distance to Open Water (m)	Using GIS, use a centroid point in the cover type polygon and measure the distance from the centroid to the edge of the nearest open water body.	FORESTS FLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR	GIS & Calculations
NEIGHBOR	Distance to Nearest Neighbor of Similar Cover Type (m)	Using GIS, use a centroid point in the cover type polygon and measure the distance from the centroid to the edge of the nearest neighbor (neighbor = polygon of similar land use classification).	FORESTS FWATER MARSH MBIOTA	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR NEWMARSH	GIS & Calculations

Table 5. Variables Gathered via GIS & Historical Records.					
VAR Code	**Variable Description**	**Methodology, Techniques and Assumptions**	**Model Applicability**	**Cover Type Cross-Reference**	**Equipment List**
PATCHSIZE	Patch Size (acres)	Using GIS, calculate the average patch size(in acres) of the polygons for each cover type present.	FORESTS FLANDSCAPE GRASSLANDS GLANDSCAPE MARSH MLANDSCAPE	BLHFOREST NEWBLHFOR UPFOREST NEWUPFOR OLDFIELD NEWOLD OPENFIELD NEWOPEN NEWMARSH	GIS & Calculations
REGIME	Hydrologic Regime (Class Data)	Using the Cowardin Classification System, record the predominant hydrologic regime for the site. Refer to the categories listed below. 1 = Permanently flooded 2 = Intermittently exposed 3 = Semipermanently flooded 4 = Seasonally flooded 5 = Temporarily flooded 6 = Saturated 7 = Intermittently flooded	FORESTS FWATER MARSH MBIOTA	BLHFOREST NEWBLHFOR NEWMARSH	Historical Data
Source: ERDC-EL, 2004b					

Field Sampling Protocol

As indicated in the HEP variable tables above, three 100-m transect were laid down within the boundaries of the indicated cover type at each site, and variables were measured at 10 meter intervals (i.e., 10 sampling stops or stations per transect were made). In this manner, 750 separate stations (i.e., 25 cover type areas x 30 stations per cover type = 750) of data were recorded in the study. In most instances, data collected on the cover type transects were averaged to generate a cover type score for the site. This strategy reduced the coefficients of variance (i.e., standard deviations of the field data). The one exception to this data-handling rule was the management of class data (e.g., VEGSTRATA), in which the modes were calculated instead of averages across transects within the cover type.

Field Sampling Locations

Reference standard sites were not potential or existing dredge disposal sites, but represented low, moderate, and high quality examples of different habitats within the study area. Data collected for these sites was used to calibrate the HSI models and compare them to the dredge disposal sites. These ten sites are listed in Table 6.

Table 6. Reference standard sites (non-disposal sites) used in the HEP analysis for the ARNS EIS.

Site Name	Navigation Miles	Size (Acres)	BLH	OF	OLF	UPL	Notes
RSR 1	352.0-356.0	1		X			Sequoyah Refuge, OK
RSR 2	352.0-356.0	1			X		Sequoyah Refuge, OK
RSR 3	352.0-356.0	1			X		Sequoyah Refuge, OK
RSR 4	352.0-356.0	1				X	Sequoyah Refuge, OK
RSR 5	352.0-356.0	1				X	Sequoyah Refuge, OK
RSKR	434.4 – 434.6	1	X				Skelly Ranch (Private)
RBL #1	440.4 – 440.8	1	X				Big Lake, OK
RBL#2	440.1 – 440.2	1	X				Big Lake – East of dam
RBL #3	440.5 – 441.0	1	X				Big Lake, OK
RTGP	Site not along the Arkansas River	1		X			Tallgrass Prairie Preserve west of Bartlesville, Oklahoma

RTGP = Reference Tallgrass Prairie Preserve OF = Open Field
RSR = Reference Sequoyah Refuge OLF = Old Field
RSKR = Reference Skelly Ranch BLH = Bottomland Hardwood
RBL = Reference Big Lake UPL= Upland Forest

Source: USACE-Tulsa, 2004

Reference impact sites were potential dredge disposal sites that served as the baseline of data with which the rest of the potential dredge disposal sites could be extrapolated from. The reference impact sites along with the extrapolation impact sites are shown in Table 7.

Performing Data Management and Statistical Analysis

Some limits to the assessment's data should be acknowledged. In some instances, extrapolations or corrections were made several weeks after sampling was concluded. In addition, some of the cover type mapping originally developed was ground-truthed, and found to be inaccurate. As a result of these area-based changes, some transects were thrown out due to incompatibility with the new classification. In those instances where transects were discarded or absent, extrapolations were made from watershed means. When data management problems arose, ERDC-EL consulted with the MEET prior to data handling, and solutions were devised with their knowledge and consent.

Calculating Baseline Conditions

Once the baseline data inventory was conducted, and both the variable means/modes and the cover type acreages were determined, the baseline conditions in terms of HUs were generated by multiplication. Strictly speaking, the means/mode values for each variable were applied to Suitability Index graphs (entered into the "X-axis" on the Suitability Index curve) and the resultant SI score (Y-axis) was recorded. An example Suitability Index graph is shown in Figure 1.

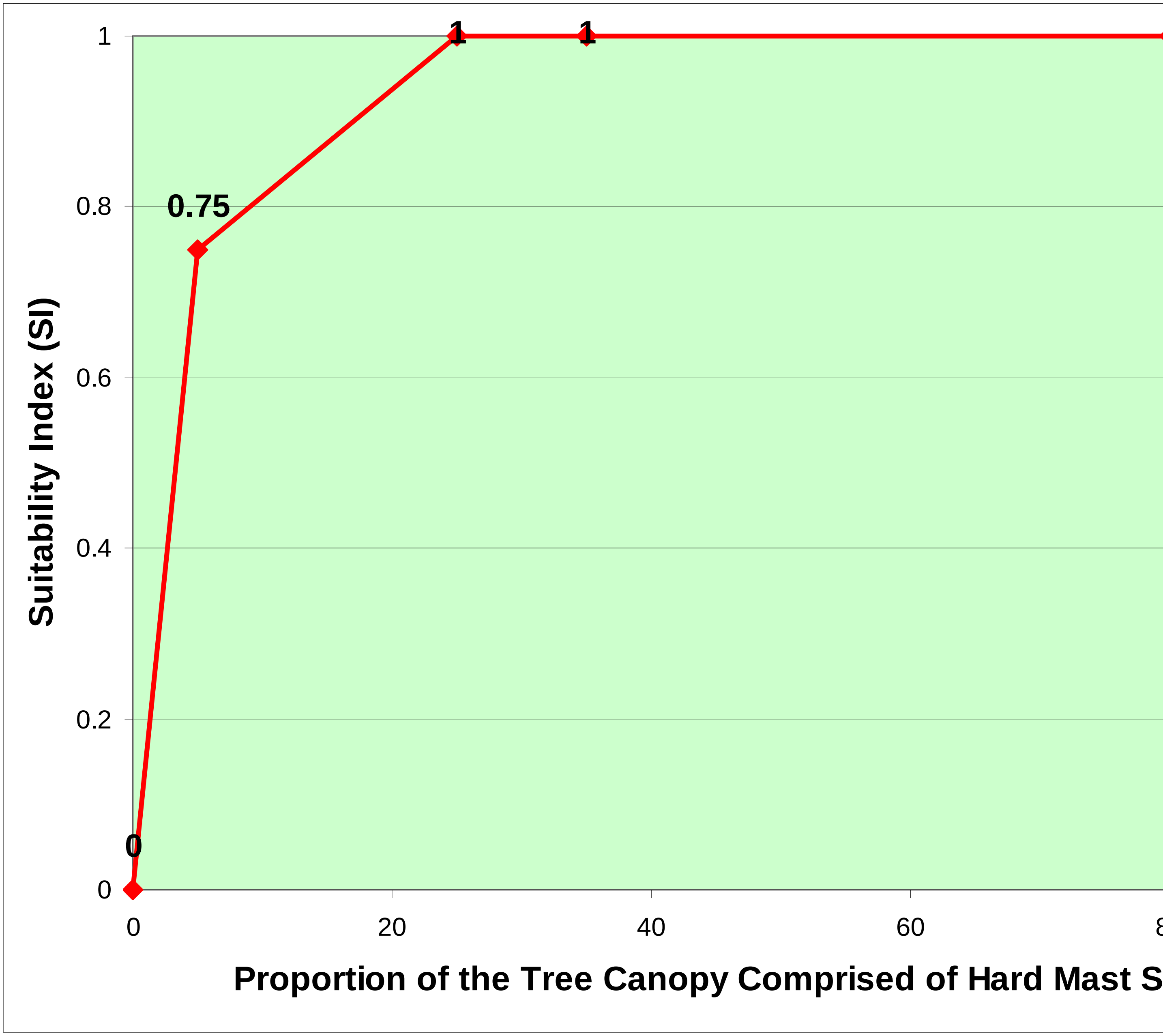

Figure 1 Example HSI Curve (*Source: ERDC-EL, 2004b*).

Table 7. Dredge disposal sites considered in the HEP analysis for the ARNS EIS.

Site Name	Deepening Disposal Site	Long Term Dredge Material Disposal Plan	Navigation Mile(s)	Acres	Cover Type					Comments
					BLH	UPL	OF	OLF	Other	
OK PRL-DI	X	X	1.5PR – 1.8PR	9			9			Poteau River; new O&M site
OK 309.1 R-DI	X	X	309.05 – 309.3	28		5	23			
OK 312.5 R-DI		X	312.5 – 312.9	19			19			
OK 315.4 R-DI	X	X	315.4 – 315.8	36		8		28		
OK 318.3 R-DI		X*	311	80		20			60	Lock 14; new O&M site
OK 335.8 R-DI*	X		335.8 – 336.1	22	8		14			Robert Kerr L&D
OK 335.9 L-DI*	X		335.8 – 336.1	22			22			Robert Kerr L&D
OK 337.2 R-DI*	X		337.7 – 337.5	28		28				Short Mountain Park
OK 338.0 R-DI	X		338.0 – 338.2	28			28			
OK-SBC 8.7 L-DI		X	SBC 8.7 – 9.3	35	8			27		Unconfined island
OK-SBC 9.7 R-DI		X	SBC 9.7 – 10.0	20	10	10				Unconfined island
OK-SBC 10.0 R-DI		X	SBC 10 – 11	20		16		4		Unconfined island
OK 342.3 L-DI	X		342.1 – 342.3	29		14		15		Two diked ponds
OK 366.5 L-DI*	X		366.3 – 366.6	6				6		Old spoil area near Lock 16
OK 382.0 L-DI	X		381.9 – 382.5	23			23			
OK 383.9 R-DI*	X		383.9 – 384.3	42		2	13	27		
OK 394.0 R-DI		X	393.9 – 394.6	48				48		3 Forks Area; new site for O&M
OK 395.2 L-DI		X	395.0 – 395.5	42				42		3 Forks Area
OK 398.2 R-DI*	X		398.2 – 398.8	44			34	10		North of Hwy 16 bridge; old disposal site
OK 400.7 R-DI*	X	X	400.0 – 401.5	31				31		
OK 400.0 L-DI		X	400.2	23				23		New site for O&M
OK 401.6 R-DI	X	X	401.5 – 402.2	39			39			

Table 7. Dredge disposal sites considered in the HEP analysis for the ARNS EIS.

Site Name	Deepening Disposal Site	Long Term Dredge Material Disposal Plan	Navigation Mile(s)	Acres	Cover Type					Comments
					BLH	UPL	OF	OLF	Other	
OK 407.6 R-DI	X		407.6 – 407.8	10		2		8		
OK 414.9 R-DI	X		414.9 – 415.15	8				8		Old disposal pit
OK 416.4 L-DI	X		416.4 – 416.65	14				14		
OK 420.8 L-DI		X	420.5 – 421.8	63		10	43		10	
OK 421.3 R-DI*	X		421.3 – 421.7	13			13			Old spoil site; closed park
OK 422.9 L-DI	X	X	421.85 – 422.0	7			7			Existing spoil site
OK 434.3 R-DI*	X		434.0 – 434.8	10				10		Old disposal pits
OK 436.1 L-DI*	X		436.1 – 436.3	13			13			
OK 441.1 L-DI*	X		441.0 – 441.5	12			12			Between river and old dredge pit
OK 443.7 L-DI	X		443.7 – 444.0	27			27			Old disposal site
OK 444.6 L-DI		X	444.5 – 445.0	15				15		
OK 444.6 R-DI		X	444.5 – 445.2	9		9				

* Reference impact sites where field, GIS, and historical data was collected for HEP.

BLH = Bottomland Hardwood Forest UPL=Upland Forest OLF = Old Field OF=Open Field

Ag = Agriculture OK = Oklahoma

Source: USACE-Tulsa, 2004

The process was repeated for every associated variable and cover type per model. The individual SI scores were then entered into the HSI formula on a cover type-by-cover type basis, and individual cover type HSIs were generated. Each answer, referred to as the cover type HSI (CT HSI), was weighted by the relative area (RA) of the cover type, and combined with the answers from the remaining associated cover types in an additive fashion. The model's formula was considered to be the sum of the CT HSIs.

The final step was to multiply the HSI result by the habitat acres (i.e., cover type acres associated with the model). The final results, referred to as Habitat Units (HUs), quantified the quality and quantity of the habitats at the site at TY0 (Baseline).

In HEP, the relative area is a mathematical process used to "weight" the various applicable cover types on the basis of quantity. To derive the relative area of a model's cover type for the study, the following equation was utilized:

$$\textit{Relative Area} = \frac{\textit{Cover Type Area}}{\textit{Total Area}}$$

Cover Type Area = only those acres assigned to the cover type of interest
Total Area = the sum of the acres utilized in the model

$$\textit{HSI Model} = \sum (\textit{CT HIS x RA})X$$

CT HSI = Results of the cover type HSI calculation
X = Number of cover types associated with the model

RA = Relative area of each cover type (ERDC-EL, 2004a). The sheer number of calculations necessary to conduct a HEP analysis on a project the size of the ARNS-EIS led the District to utilize the ERDC-EL for technical assistance. Using the latest technological advancements, ERDC-EL performed the necessary evaluations in less than six months. In addition to facilitating the application of HEP in the study, ERDC's biologists used the EXHEP (Expert Habitat Evaluation Procedures) software package to generate habitat loss and mitigation calculations in a timely manner (ERDC-EL, 2004b).

The baseline analysis results for the reference and potential disposal sites sampled in the field are presented in Table 8.

Table 8. Baseline HEP Results for RIS and RSS.

Site Name	Model name	Habitat Suitability Index (HSI)	Applicable Acres	Baseline Habitat Units (HUs)
RBL #1	Upland Forest Community Model	0.83	525	435.9
	Grassland Community Model	0.00	0	0.0
RBL #2	Upland Forest Community Model	0.65	158	103.1
	Grassland Community Model	0.00	0	0.0
RBL #3	Upland Forest Community Model	0.55	97	53.3
	Grassland Community Model	0.00	0	0.0

Table 8. Baseline HEP Results for RIS and RSS.				
Site Name	**Model name**	**Habitat Suitability Index (HSI)**	**Applicable Acres**	**Baseline Habitat Units (HUs)**
RSKR1	Upland Forest Community Model	0.33	55	18.1
	Grassland Community Model	0.00	0	0.0
OK335.8R-DI	Upland Forest Community Model	0.29	8	2.3
	Grassland Community Model	0.31	14	4.3
OK434.3R-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.28	10	2.8
RSR 4	Upland Forest Community Model	0.79	289	228.1
	Grassland Community Model	0.00	0	0.0
RSR 5	Upland Forest Community Model	0.60	132	79.4
	Grassland Community Model	0.00	0	0.0
OK 398.2 R-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.41	44	17.9
OK 337.2 R-DI	Upland Forest Community Model	0.69	28	19.3
	Grassland Community Model	0.00	0	0.0
OK 383.9 R-DI	Upland Forest Community Model	0.69	2	1.4
	Grassland Community Model	0.379	40	15.2
RSR 2	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.65	58	37.6
RSR 3	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.66	113	74.7
OK366.5L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.59	6	3.6
RSR 1	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.69	1066	739.3
RTGP	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.95	790	751.9
OK 422.9 L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.16	7	1.1

Table 8. Baseline HEP Results for RIS and RSS.				
Site Name	**Model name**	**Habitat Suitability Index (HSI)**	**Applicable Acres**	**Baseline Habitat Units (HUs)**
OK441.1L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.53	12	6.4
OK 421.3 R-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.31	13	4.1
OK 335.9 L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.30	22	6.5
OK400.7R-DI	Upland Forest Community Model	0.0	0	0.0
	Grassland Community Model	0.39	31	12.0
OK 436.1 L-DI	Upland Forest Community Model	0.00	0	0.0
	Grassland Community Model	0.22	13	2.8
Source: ERDC-EL, 2004b				

Generating Without Project Conditions and Calculating Outputs

Future impacts were projected as change from these baseline conditions over the 50-year project life in the HEP assessments. The ERDC-EL facilitated a series of workshops, beginning in the winter of 2004 and continuing through the summer of 2004, in which the MEET derived future projections for each site.

To analyze impacts to a community or region, it becomes necessary to predict both the short-term and long-term future conditions of the environment. The Without Project condition is universally regarded as a vital and important element of the evaluation. No single element is more critical to the impacts analysis than the prediction of the most likely future conditions anticipated for the study area if no action is taken as a result of the study. NEPA regulations require that the No Action Alternative always be considered during the formulation of plans. The Without Project descriptions had to adequately describe the future. Significant variables, elements, trends, systems, and processes were sufficiently described to support good decision-making. Forecasts were based on appropriate methods, and professional standards were applied to the use of those methods. Without Project conditions are not "before-and-after" comparisons. "Before-and-after" comparisons can overlook the causality that is important to effective plan evaluation. Without Project conditions are future oriented.

Rules and assumptions were developed for acreage projections of the Without Project condition for all ARNS-EIS sites:

- Because of the rural nature of most of the dredge disposal sites, there would likely be little change in ownership and/or change in function of land within these project areas.
- Pasture would likely remain pasture due to grazing pressure.

- Open fields would likely undergo succession and develop into old fields and then forest.
- Old fields would likely undergo succession to develop into forest.
- Forest would likely continue to develop into a more mature forest.
- Marsh would likely undergo succession to develop into a forested wetland.

Some of the projections were based on data collected at the RISs, while others were adjusted based on expert opinion. These assumptions were applied as results to the Habitat Suitability curves and new HSIs and HUs were generated for the without project condition.

Calculating Annualized Units for the Without Project Condition

Most Federal agencies use annualization as a means to display benefits and costs. Federal projects are evaluated over a period of time that is referred to as the "life of the project." This is defined as that period between the time that the project becomes operational and the end of the project life. In HEP, HUs are annualized by summing HUs across all years in the period of analysis and dividing the total (cumulative HU) by the number of years in the life of the project. In this manner, pre-start changes can be considered in the analysis. The results of this calculation are referred to as Average Annual Habitat Units (AAHUs).

The total acres of each habitat projected to be gained plus the AAHUs for each terrestrial site under the without project or no action alternative is shown in Table 9.

Table 9. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
OK PR L-DI	Extrapolated Site	NewOldField	2.3	0.85
		NewUpland	2.3	0.16
		OpenField	4.5	1.69
OK PR L-DI Total			9.0	2.69
OK 309.1 R-DI	Extrapolated Site	NewOldField	5.8	3.00
		NewUpland	5.8	0.81
		OpenField	11.5	6.00
		UplandForest	5.0	3.57
OK 309.1 R-DI Total			28.0	13.38
OK 312.5 R-DI	Extrapolated Site	NewOldField	4.8	1.02
		NewUpland	4.8	0.31
		OpenField	9.5	2.04
OK 312.5 R-DI Total			19.0	3.37
OK 315.4 R-DI	Extrapolated Site	NewUpland	14.0	4.11
		OldField	14.0	7.24

Table 9. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
		UplandForest	8.0	2.35
OK 315.4 R-DI Total			36.0	13.70
OK 318.3 R-DI	Extrapolated Site	UplandForest	20.0	5.88
OK 318.3 R-DI Total			20.0	5.88
OK 335.8R-DI	Reference Impact Site	Bottomland	8.0	3.91
		NewOldField	3.5	0.85
		NewUpland	3.5	3.91
		OpenField	7.0	1.69
OK 335.8R-DI Total			22.0	10.36
OK 335.9L-DI	Reference Impact Site	NewOldField	5.5	0.85
		NewUpland	5.5	0.36
		OpenField	11.0	1.69
OK 335.9L-DI Total			22.0	2.90
OK 337.2R-DI	Reference Impact Site	UplandForest	28.0	20.01
OK 337.2R-DI Total			28.0	20.01
OK 338.0 R-DI	Extrapolated Site	NewOldField	7.0	1.50
		NewUpland	7.0	0.46
		OpenField	14.0	3.01
OK 338.0 R-DI Total			28.0	4.97
OK 342.3 L-DI	Extrapolated Site	NewUpland	7.5	1.05
		OldField	7.5	3.91
		UplandForest	14.0	10.01
OK 342.3 L-DI Total			29.0	14.97
OK-SBC 10.0 R-DI	Extrapolated Site	NewUpland	1.0	0.29
		OldField	1.0	0.52
		UplandForest	16.0	4.70
OK-SBC 10.0 R-DI Total			18.0	5.51
OK-SBC 8.7 L-DI	Extrapolated Site	Bottomland	2.0	0.98

Table 9. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
		NewUpland	4.0	0.56
		OldField	4.0	2.09
OK-SBC 8.7 L-DI Total			10.0	3.63
OK-SBC 9.7 R-DI	Extrapolated Site	Bottomland	5.0	2.44
		UplandForest	5.0	1.47
OK-SBC 9.7 R-DI Total			10.0	3.91
OK 366.5L-DI	Reference Impact Site	NewUpland	3.0	0.72
		OldField	3.0	2.35
OK 366.5L-DI Total			6.0	3.07
OK 382.0 L-DI	Extrapolated Site	NewOldField	5.8	2.38
		NewUpland	5.8	0.39
		OpenField	11.5	4.77
OK 382.0 L-DI Total			23.0	7.54
OK 383.9R-DI	Reference Impact Site	NewOldField	3.3	1.68
		NewUpland	16.8	4.92
		OldField	13.5	6.98
		OpenField	6.5	3.36
		UplandForest	2.0	0.59
OK 383.9R-DI Total			42.0	17.53
OK 394.0 R-DI	Extrapolated Site	NewUpland	24.0	5.78
		OldField	24.0	18.82
OK 394.0 R-DI Total			48.0	24.60
OK 395.2 L-DI	Extrapolated Site	NewUpland	9.0	2.17
		OldField	9.0	7.06
OK 395.2 L-DI Total			18.0	9.23
OK 398.2R-DI	Reference Impact Site	NewOldField	8.5	4.43
		NewUpland	13.5	1.90
		OldField	5.0	2.61
		OpenField	17.0	8.87
OK 398.2R-DI Total			44.0	17.81

Table 9. Without Project Projected Acres and AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WOP Target Year 51 Size (acres)	Target Year 51 AAHUs
OK 400.0 L-DI	Extrapolated Site	NewUpland	11.5	2.83
		OldField	11.5	6.01
OK 400.0 L-DI Total			23.0	8.84
OK 400.7R-DI	Reference Impact Site	NewUpland	15.5	3.81
		OldField	15.5	8.10
OK 400.7R-DI Total			31.0	11.91
OK 401.6 R-DI	Extrapolated Site	NewOldField	9.8	6.59
		NewUpland	9.8	0.68
		OpenField	19.5	13.18
OK 401.6 R-DI Total			39.0	20.45
OK 407.6 R-DI	Extrapolated Site	NewUpland	4.0	0.56
		OldField	4.0	2.09
		UplandForest	2.0	1.43
OK 407.6 R-DI Total			10.0	4.08
OK 414.9 R-DI	Extrapolated Site	NewUpland	4.0	0.96
		OldField	4.0	3.14
OK 414.9 R-DI Total			8.0	4.10
OK 416.4 L-DI	Extrapolated Site	NewUpland	7.0	1.69
		OldField	7.0	5.49
OK 416.4 L-DI Total			14.0	7.18
OK 420.8 L-DI	Extrapolated Site	NewOldField	10.8	5.56
		NewUpland	10.8	1.69
		OpenField	21.5	11.11
		UplandForest	10.0	2.94
OK 420.8 L-DI Total			53.0	21.30
OK 421.3R-DI	Reference Impact Site	NewOldField	3.3	1.35
		NewUpland	3.3	0.22
		OpenField	6.5	2.69
OK 421.3R-DI Total			13.0	4.26
OK 422.9L-DI	Reference Impact Site	NewOldField	1.8	0.61

Table 9. Without Project Projected Acres and AAHUs at Target Year 51.				
Site Name	**Site Type**	**Habitat**	**WOP Target Year 51 Size (acres)**	**Target Year 51 AAHUs**
		NewUpland	1.8	0.12
		OpenField	3.5	1.22
OK 422.9L-DI Total			7.0	1.95
OK 434.3R-DI	Reference Impact Site	NewUpland	5.0	0.52
		OldField	5.0	1.99
OK 434.3R-DI Total			10.0	2.51
OK 436.1L-DI	Reference Impact Site	NewOldField	3.3	1.22
		NewUpland	3.3	0.23
		OpenField	6.5	2.44
OK 436.1L-DI Total			13.0	3.89
OK 441.1L-DI	Reference Impact Site	NewOldField	3.0	2.03
		NewUpland	3.0	0.21
		OpenField	6.0	4.05
OK 441.1L-DI Total			12.0	6.29
OK 443.7 L-DI	Extrapolated Site	NewOldField	6.8	1.45
		NewUpland	6.8	0.44
		OpenField	13.5	2.90
OK 443.7 L-DI Total			27.0	4.79
OK 444.6 L-DI	Extrapolated Site	NewUpland	7.5	1.81
		OldField	7.5	5.88
OK 444.6 L-DI Total			15.0	7.69
Grand Total			**270.0**	**102.59**
Source: ERDC-EL, 2004b				

Generating With Project Conditions and Calculating the Outputs

Between June of 2004 and September of 2004 the MEET met on a regular basis (in person and via conference calls) to develop projection trends for the deepening and maintenance dredging disposal sites across the MKARNS. As they did in the without project setting, the MEET generated a list of general trends for the overall study. It was assumed that if a site was used for disposal, the entire site would be covered by dredged material. The Team made an effort to distinguish clearly between forest vs. open/old field communities, and the outcomes of each were incorporated into the forecasting.

Table 10 shows with project total acres, AAHUs, and net AAHUs at target year 50.

Table 10. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WP TY50 Size (ac)	AAHUs	Net AAHUs
OK 309.1 R-DI	Extrapolated Site	NewOldField	0	0.03	-2.97
		NewUpland	0	0.00	-0.81
		OpenField	0	0.08	-7.10
		UplandForest	0	0.13	-3.45
OK 309.1 R-DI Total			0	0.24	-14.32
OK 312.5 R-DI	Extrapolated Site	NewOldField	0	0.01	-1.01
		NewUpland	0	0.00	-0.64
		OpenField	0	0.03	-2.33
OK 312.5 R-DI Total			0	0.05	-3.97
OK 315.4 R-DI	Extrapolated Site	NewUpland	0	0.01	-4.11
		OldField	0	0.00	-6.59
		UplandForest	0	0.00	-2.35
OK 315.4 R-DI Total			0	0.01	-13.05
OK 318.3 R-DI	Extrapolated Site	UplandForest	0	0.13	-5.75
OK 318.3 R-DI Total			0	0.13	-5.75
OK 335.8R-DI	Reference Impact Site	Bottomland Forest	0	0.02	-3.89
		NewOldField	0	0.01	-0.84
		NewUpland	0	0.02	-3.89
		OpenField	0	0.02	-1.71
OK 335.8R-DI Total			0	0.06	-10.33
OK 335.9L-DI	Reference Impact Site	NewOldField	0	0.01	-1.17
		NewUpland	0	0.00	-0.36
		OpenField	0	0.03	-2.70
OK 335.9L-DI Total			0	0.05	-4.23
OK 337.2R-DI	Reference Impact Site	UplandForest	0	0.13	-19.89
OK 337.2R-DI Total			0	0.13	-19.89
OK 338.0 R-DI	Extrapolated Site	NewOldField	0	0.01	-1.49
		NewUpland	0	0.00	-0.70
		OpenField	0	0.03	-3.45
OK 338.0 R-DI Total			0	0.05	-5.64
OK 342.3 L-DI	Extrapolated Site	NewUpland	0	0.00	-1.05
		OldField	0	0.02	-4.66
		UplandForest	0	0.13	-9.88
OK 342.3 L-DI Total			0	0.15	-15.59
OK 366.5L-DI	Reference Impact Site	NewUpland	0	0.00	-0.72
		OldField	0	0.02	-2.33
OK 366.5L-DI Total			0	0.02	-3.05

Table 10. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.

Site Name	Site Type	Habitat	WP TY50 Size (ac)	AAHUs	Net AAHUs
OK 382.0 L-DI	Extrapolated Site	NewOldField	0	0.01	-2.38
		NewUpland	0	0.00	-0.47
		OpenField	0	0.02	-4.75
OK 382.0 L-DI Total			0	0.02	-7.60
OK 383.9R-DI	Reference Impact Site	NewOldField	0	0.00	-1.68
		NewUpland	0	0.01	-4.91
		OldField	0	0.00	-6.36
		OpenField	0	0.00	-2.84
		UplandForest	0	0.00	-0.59
OK 383.9R-DI Total			0	0.02	-16.38
OK 394.0 R-DI	Extrapolated Site	NewUpland	0	0.00	-5.78
		OldField	0	0.02	-18.80
OK 394.0 R-DI Total			0	0.02	-24.58
OK 395.2 L-DI	Extrapolated Site	NewUpland	0	0.00	-2.17
		OldField	0	0.02	-7.04
OK 395.2 L-DI Total			0	0.02	-9.20
OK 398.2R-DI	Reference Impact Site	NewOldField	0	0.03	-4.40
		NewUpland	0	0.00	-1.90
		OldField	0	0.02	-3.10
		OpenField	0	0.08	-10.53
OK 398.2R-DI Total			0	0.13	-19.92
OK 400.0 L-DI	Extrapolated Site	NewUpland	0	0.00	-2.83
		OldField	0	0.08	-5.93
OK 400.0 L-DI Total			0	0.08	-8.76
OK 400.7R-DI	Representative Site	NewUpland	0	0.00	-3.81
		OldField	0	0.08	-8.02
OK 400.7R-DI Total			0	0.08	-11.83
OK 401.6 R-DI	Extrapolated Site	NewOldField	0	0.01	-6.58
		NewUpland	0	0.00	-0.16
		OpenField	0	0.03	-15.27
OK 401.6 R-DI Total			0	0.05	-22.00
OK 407.6 R-DI	Extrapolated Site	NewUpland	0	0.00	-0.56
		OldField	0	0.02	-2.47
		UplandForest	0	0.13	-1.30
OK 407.6 R-DI Total			0	0.15	-4.34
OK 414.9 R-DI	Extrapolated Site	NewUpland	0	0.00	-0.96
		OldField	0	0.02	-3.11
OK 414.9 R-DI Total			0	0.02	-4.08
OK 416.4 L-DI	Extrapolated Site	NewUpland	0	0.00	-1.69
		OldField	0	0.02	-5.47

Table 10. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.					
Site Name	**Site Type**	**Habitat**	**WP TY50 Size (ac)**	**AAHUs**	**Net AAHUs**
OK 416.4 L-DI Total			0	0.02	-7.15
OK 420.8 L-DI	Extrapolated Site	NewOldField	0	0.00	-5.56
		NewUpland	0	0.00	-0.67
		OpenField	0	0.00	-9.39
		UplandForest	0	0.00	-2.94
OK 420.8 L-DI Total			0	0.00	-18.56
OK 421.3R-DI	Reference Impact Site	NewOldField	0	0.01	-1.34
		NewUpland	0	0.00	-0.22
		OpenField	0	0.02	-2.68
OK 421.3R-DI Total			0	0.02	-4.24
OK 422.9L-DI	Reference Impact Site	NewOldField	0	0.00	-0.61
		NewUpland	0	0.00	-0.12
		OpenField	0	0.00	-0.98
OK 422.9L-DI Total			0	0.01	-1.71
OK 434.3R-DI	Reference Impact Site	NewUpland	0	0.00	-0.52
		OldField	0	0.02	-1.97
OK 434.3R-DI Total			0	0.02	-2.49
OK 436.1L-DI	Reference Impact Site	NewOldField	0	0.01	-1.21
		NewUpland	0	0.00	-0.23
		OpenField	0	0.01	-1.58
OK 436.1L-DI Total			0	0.01	-3.02
OK 441.1L-DI	Reference Impact Site	NewOldField	0	0.01	-2.01
		NewUpland	0	0.00	-0.21
		OpenField	0	0.03	-4.68
OK 441.1L-DI Total			0	0.05	-6.90
OK 443.7 L-DI	Extrapolated Site	NewOldField	0	0.01	-1.44
		NewUpland	0	0.00	-0.44
		OpenField	0	0.03	-3.32
OK 443.7 L-DI Total			0	0.05	-5.20
OK 444.6 L-DI	Extrapolated Site	NewUpland	0	0.00	-1.81
		OldField	0	0.02	-5.86
OK 444.6 L-DI Total			0	0.02	-7.67
OK 444.6 R-DI	Extrapolated Site	UplandForest	0	0.13	-8.45
OK 444.6 R-DI Total			0	0.13	-8.45
OK PR L-DI	Extrapolated Site	NewOldField	0	0.01	-0.84
		NewUpland	0	0.00	-0.40
		OpenField	0	0.01	-1.09
OK PR L-DI Total			0	0.01	-2.33
OK-SBC 10.0 R-DI	Extrapolated Site	NewUpland	0	0.01	-0.29

Table 10. With Project Total Acres, AAHUs, and Net AAHUs at Target Year 51.					
Site Name	**Site Type**	**Habitat**	**WP TY50 Size (ac)**	**AAHUs**	**Net AAHUs**
		OldField	0	0.00	-0.47
		UplandForest	0	0.00	-4.70
OK-SBC 10.0 R-DI Total			0	0.01	-5.45
OK-SBC 8.7 L-DI	Extrapolated Site	Bottomland Forest	0	0.02	-0.96
		NewUpland	0	0.00	-0.56
		OldField	0	0.02	-2.47
OK-SBC 8.7 L-DI Total			0	0.04	-4.00
OK-SBC 9.7 R-DI	Extrapolated Site	Bottomland Forest	0	0.02	-2.43
		UplandForest	0	0.00	-1.47
OK-SBC 9.7 R-DI Total			0	0.02	-3.89
Grand Total			0	1.89	-305.57
Source: ERDC-EL, 2004b					

Mitigation

As part of mitigation the MEET selected dredge disposal sites based upon criteria for avoidance and minimization. Wherever possible, potential dredged material disposal sites were not located where they would impact mature upland forest, bottomland hardwoods, or wetlands, and relocating the sites was logistically feasible. Where sites could not be relocated outside these three habitat types, the design of the pit was configured to reduce impacts as much as possible. Priority was given to sites on USACE owned land. If suitable USACE land was not available, the team looked for private agricultural lands and possible in-water disposal locations where there was the potential for beneficial use of the dredged material. This ultimately reduced the acreage of land needed for mitigation.

Ten sites in Oklahoma were chosen as potential mitigation sites. The MEET team evaluated these sites to determine the amount and type of habitat that could be created to mitigate for habitat lost during dredge disposal on terrestrial sites. Many of the potential mitigation sites occurred on agricultural land. Incremental costs analyses were conducted using the procedures identified in the Corps procedures manual for conducting cost effectiveness and incremental cost analyses (IWR Report #95-R-1, Corps, May 1995). The detailed incremental cost analyses report is located in the Feasibility Report for the Arkansas River Navigation Study.

Two sites were ultimately selected that both satisfied all members of the MEET team and fulfilled the acreage and habitat quality requirement needed to mitigate for the potential habitat loss. These sites were adjacent to ODWC currently managed lands, and allowed ODWC to easily maintain and operate the mitigation sites using funds from the USACE. Figure C.5-2 shows a map of the mitigation sites selected.

Baseline Assumptions for Mitigation

The assumptions for mitigation were as follows:

- All mitigation sites will be continually disturbed and will have no fish and wildlife value.
- All mitigation sites begin as agricultural cropland (AGCROP).
- Without project – all mitigation sites remain the same cover type & quality (HSI=0) over time.
- It was agreed among the agencies paying for and managing the mitigation land that the sites would be flooded and maintained to facilitate development of marsh and bottomland forest habitat. Between the time the sites are flooded with water and the time that BLHFOREST has developed, the sites were considered "NEWMARSH." ERDC suggested using the Marsh Wren HSI model published by the USFWS with the modifications of adding the landscape parameters to capture the NEWMARSH creation.
- BLHFOREST can only be replaced with NEWBLHFOREST.
- UPFOREST can only be replaced with NEWBLHFOREST.
- OLDFIELD and OPENFIELD can be replaced with NEWBLHFOREST and/or NEWMARSH.

Table 11 shows the total acres and AAHUs of terrestrial habitat that could potentially be lost during 50 years of dredge disposal.

Table 11 Acres and AAHUs of each habitat type potentially lost via dredge disposal over the entire 50 years of the project.

BLHFOREST		UPFOREST		OLDFIELD		OPENFIELD	
Acres Lost	AAHUs Lost	Acres Lost	AAHUs Lost	Acres Lost	AAHUs Lost	Acres Lost	AAHUs Lost
-15	**-7.3**	**-287**	**-76.4**	**-220**	**-123.8**	**-170**	**-71.0**

Source: ERDC-EL, 2004b

The mitigation sites were run through HEP, which resulted in 130 acres of newly created bottomland forest and 248 acres of newly created marsh (Table 12).

Table 12 Acres and AAHUs gained by habitat type at two mitigation sites over the entire 50 years of the project.

	BLHFOREST		UPFOREST		OLDFIELD		OPENFIELD		MARSH	
Mitigation Site	Acres Gained	Net AAHUs Gained	Acres Gained	AAHUs Gained	Acres Gained	AAHUs Gained	Acres Gained	AAHUs Gained	Acres Gained	AAHUs Gained
OK408.9L-M	**69**	**48.3**	0	0.0	0	0.0	0	0.0	**91**	**66.6**
OK405.0L-M	**61**	**42.7**	0	0.0	0	0.0	0	0.0	**157**	**131.3**

Totals	**130**	**91.0**	0	0.0	0	0.0	0	0.0	**248**	**197.9**
Source: ERDC-EL, 2004b										

Conclusions

It was determined that though the HEP analysis 302 acres of forested habitat and 390 acres of grassland habitat would be lost with the use of all potential dredge disposal sites over the 50 year project life. A total of 130 acres of higher quality bottomland forest habitat and 248 acres of higher quality marsh habitat would mitigate for these lost acres through wetland creation along portions of the MKARNS.

The "Net HSI Gain" column in Table 13 is the level of quality that the mitigation will be designed to meet. The new bottomland forest and marsh habitat created would mitigate for the impacts from disposing dredge material on the terrestrial sites because the quality of the habitat created through mitigation (HSI = 0.70-0.75) is much higher than that lost through dredge disposal (0.28-0.50), and therefore, far fewer acres of new habitat is required to replace it.

The actual acreages needed to fully mitigate for the forest and grassland habitat lost is 120 acres of bottomland forest and 258 acres of marsh (0.7 HSI * 120 acres = 84 AAHUs of bottomland forest; 0.75 HSI * 248 acres = 194 AAHUs). Approximately 10 surplus acres of NEWBLHFOR created and a shortage of 10 acres of NEWMARSH would be created, resulting in no total surplus or shortage of acres.

Table 13 Summary of acres, AAHUs, and Annual HSI lost on dredge disposal sites and gained on mitigation sites.

Mitigation Sites Selected: OK408.9L-M, OK405.0 L-M

Cover Type Mitigated For	Sum of Acres Lost	Sum of AAHUs Lost	Average Annual HSI of Acres Lost	Total Acres of Proposed Mitigation Sites Combined	Net Gain in AAHUs from Mitigation Plans	Net HSI Gain	# Acres Needed to Fully Mitigate	Surplus or Shortage of Acres	Mitigation Ratio
FOREST (BLHFOREST, UPFOREST)	**-302**	**-83.7**	**0.28**	**130 (NEWBLHFOR)**	**91.0**	**0.70**	**120**	**10**	**0.4:1**
GRASSLAND (OLDFIELD, OPENFIELD)	**-390**	**-194.8**	**0.50**	**248 (NEWMARSH)**	**187.0**	**0.75**	**258**	**-10**	**0.7:1**
							Total Surplus or Shortage of Acres:	**0**	

Source: ERDC-EL, 2004b

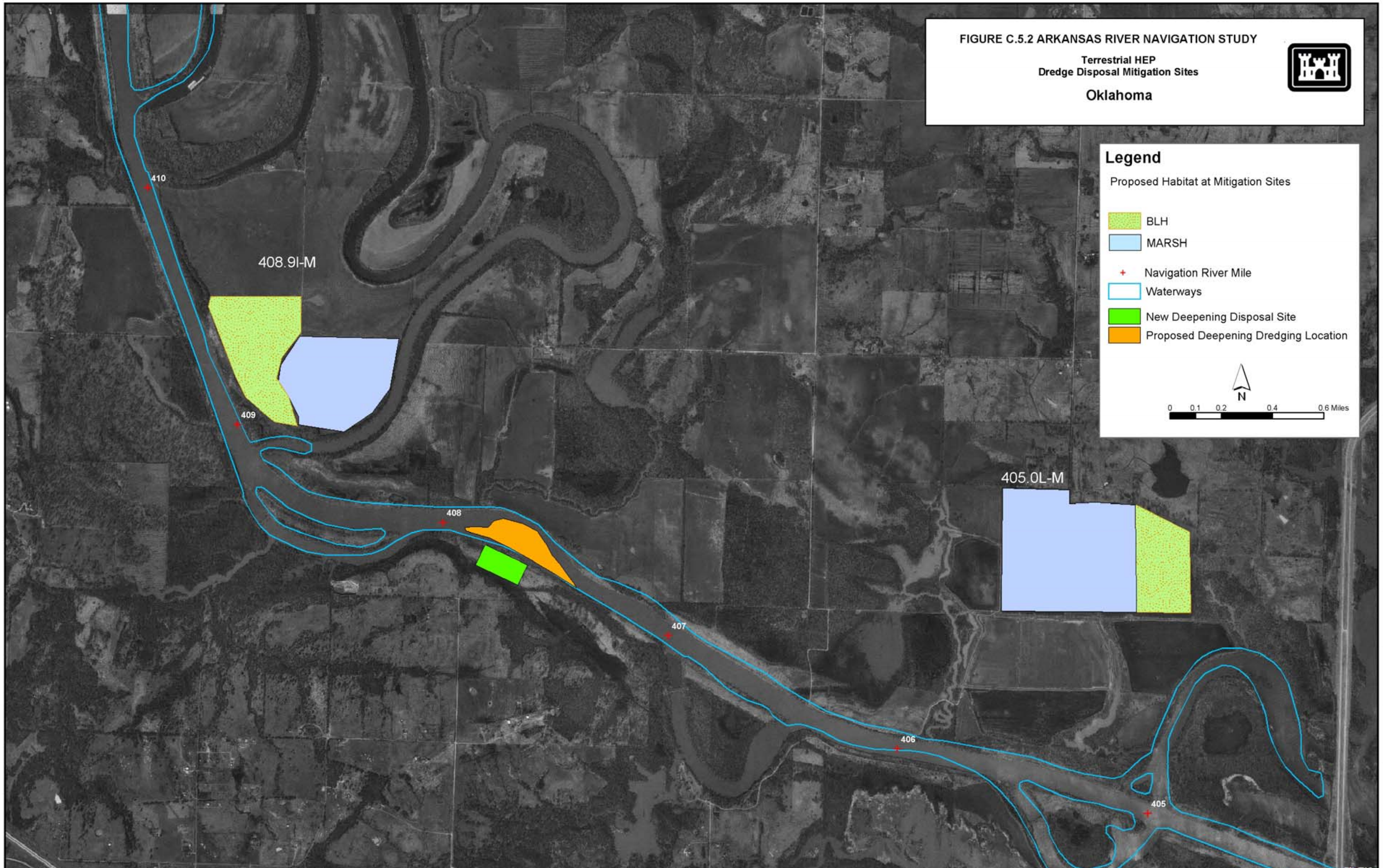
FIGURE C.5.2 ARKANSAS RIVER NAVIGATION STUDY
Terrestrial HEP
Dredge Disposal Mitigation Sites
Oklahoma
Legend
Proposed Habitat at Mitigation Sites
BLH
MARSH
Navigation River Mile
Waterways
New Deepening Disposal Site
Proposed Deepening Dredging Location
N
0 0.1 0.2 0.4 0.6 Miles
408.9I-M
405.0L-M
410
409
408
407
406
405

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Acronyms

AAHU	Average Annual Habitat Units
AGFC	Arkansas Game and Fish Commission
cm	centimeters
CT-HSI	Cover Type HSI
dbh	diameter at breast height
EIS	Environmental Impact Study
ERDC-EL	Engineer Research and Development Center – Environmental Laboratory
GIS	Geographic Information Systems
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
HU	Habitat Units
m	meters
MEET	Multiagency Ecosystem Evaluation Team
MKARNS	McClellan-Kerr Arkansas River Navigation System
ODWC	Oklahoma Department of Wildlife Conservation
RA	Relative Acres
RIS	Reference Impact Sites
RSS	Reference Standard Sites
SI	Suitability Index
TY	Target Year
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service